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CAPITAL BUDGETING AND THE INVESTMENT CREDIT*

Myles M. Dryden**

The large flood of literature on the topic of capital budgeting during the last ten years has tended to focus around two or three key problem areas. In particular the problem of the cost-of-capital has received considerable discussion and is still a controversial and knotty topic. The question of the correct criterion to use in making capital budgeting decisions, especiallly the relative merits of the present value criterion and the internal rate-of-return, has received attention. In addition to this writers and researchers have revealed in much more detail the nature of economic relationships and practices in this important area of managerial decision making.[1] This literature, however, contains relatively little explicit consideration of the impact of fiscal measures on the budgetary process. This aspect of the subject has usually been treated from either a qualitative standpoint or considered more from a macro-economic point-of-

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1 A good cross-section of the problems treated may be found in The Management of Corporate Capital, edited by Ezra Solomon (Glencoe, Illinois: Free Press, 1959). A comprehensive and pragmatic presentation in a practical decision-making context is provided by The Capital Budgeting Decision (New York: Macmillan Company, 1960) by Harold Bierman Jr. and Seymour Smidt. A formal and sophisticated treatment, emphasizing the relationship between production and investment, is provided by Vernon L. Smith's Investment and Production: A Study on the Theory of the Capital-Using Enterprise (Cambridge, Massachusetts: Harvard University Press, 1961). Donald F. Istvan presents a picture of current corporate capital budgeting practices in Capital-Expenditure Decisions: How they are made in large Corporations (Graduate School of Business Indiana, Report No. 33, 1961).

view, stressing the public finance aspects of the problem rather than analyzed for its impact on investment decisions at the micro-economic level. Recent changes in depreciation laws and the availability of a tax-credit for qualified investment expenditures, however, have re-emphasized the need to examine more carefully how such measures might affect investment decisions at the level of the firm.

This paper examines the possible effects of the investment credit which recently became part of the tax laws. The focus here is on the problem of establishing the extent of the stimulus provided by the investment credit when applied to a given investment opportunity. A secondary topic discussed here is the way in which the parameters of an investment opportunity (particularly its life) affect the size of the stimulus. Finally, it will be seen that a firm's depreciation policy enters strongly into the determination of the impact of the investment credit on a given investment opportunity's profitability. This is particularly evident in examining the problem of whether or not the investment credit changes the optimal lives of assets. As might be expected the presence of the investment credit does in general change the optimal life. It is important to consider if these changes are systematic and whether or not there are depreciation policies which lead to the same optimal life for an asset, whether or not the investment credit is taken into consideration. Before attacking these problems it is necessary to indicate briefly what the investment credit is and to define appropriate notation.

For the purposes of this paper all that need be known about the investment credit[2] is the following: for qualified investment expenditures a corporation can receive a deduction from its tax liability by an amount which is a function of the dollar amount of the investment and its life. This deduction from its taxes is also made from the depreciable base of the asset. For example an asset costing $1,000 with a 10 year life qualifies for a reduction in the corporation's tax liability of an amount equal to $70. The amount which the corporation can then depreciate is $930. It is assumed here that the deduction to be made from the corporation's tax liability can in fact be made, that is, that the carry-forward/carry-back provisions of the law need not be invoked and that the deduction is made available immediately. This latter assumption introduces a slight element of bias into the discussion since, given the present institutional arrangements the payment of taxes and the occurrence of the liability for taxes are non-synchronous events. If the cost of the asset is C and the investment credit (in decimal form) is k it is assumed that the asset can be purchased for a net immediate payment of C(1 - k).

The model assumed in this analysis is the standard normative present value model.[3] There is evidence to suggest that this approach, (para

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[2] For the principal characteristics of the investment credit see Appendi

[3] As developed, for example, by Friedrich and Vera Lutz, The Theory of Investment of the Firm (Princeton, New Jersey: Princeton University Press, 1951).

Given these data and, for the present, assuming the asset has no salvage value, the present value of the investment, assuming continuous discounting, is:

$$(1) \qquad PV_0 = \int_0^n (1-T)R(t)e^{-rt}\,dt + TC\int_0^n d(t, n)e^{-rt}\,dt - C$$

The availability of an investment credit (k_n)[5] for this asset would give a new present value of:

$$(2) \qquad PV_1 = \int_0^n (1-T)R(t)e^{-rt}\,dt + T(C - kC)\int_0^n d(t, n)e^{-rt}\,dt - C + kC$$

Equations (1) and (2) represent the present value of the after-tax cash flows of a given investment opportunity calculated without and with the application of the investment credit respectively. Note that in addition to assuming that the asset has no salvage value it is further assumed that the parameters of the investment do not change--in particular the life (n) is not recalculated when the switch to employing the investment credit is made--nor does the depreciation policy d(t, n). The consideration of these complications is reserved until later.

Given this highly simplified model the question to be explored is: to what extent does the introduction of the investment credit (k) stimulate

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[5] See Appendix A. The investment credit is a function of asset life and is denoted generally by k_n. Unless the context is ambiguous the subscript will not be used. The value for k is assumed to be in decimal form, as is T.

investment?[6] A convenient approach to an analysis of the stimulating effect of the investment credit is to consider its effect on "marginal" investments, that is, those which are just on the borderline between acceptance and rejection prior to the application of the credit. This would mean looking at the effect on investments for which PV_o equals zero.[7] This bench-mark seems to square with businessmen's thinking in the sense that they appear to weigh the effect of the investment credit in relation to "marginal" projects. Thus, for example, a recent survey by the Wall Street Journal found that over 50% of the corporate executives interviewed indicated that the introduction of an investment credit would "cause them to take a second look at 'marginal' projects."[8] A more general approach to the problem, however, may be made by not restricting the analysis to the case in which PV_o is zero. Pursuing this approach the increase in present value attributable to the availability of the investment credit is given by equation (3):

$$(3) \qquad PV_1 - PV_o = \Delta PV = kC\left(1 - T\int_o^n d(t, n)e^{-rt}\,dt\right)$$

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6 The present-value model, of course, simply says accept investments whose present value at the cost-of-capital is positive. Depending on how the investment alternatives are specified at the point of decision, one may wish to modify this rule to permit the acceptance of investments with negative present value provided that their acceptance, along with some other (economically related) projects, leads to a net increase in present value. Such interdependence may be called complementarity.

7 Analysis of this problem using other decision criteria would, of course, proceed from different definitions of marginal. E.Cary Brown analyzed the effects of an earlier variant of the present investment credit using the implied assumption that the internal rate-of-return equalled the market rate of interest; see his "Tax Incentives for Investment", American Economic Review, Vol. LII, May 1962, pp. 335-45.

8 Wall Street Journal, February 8, 1962.

It is convenient to write this in terms of the increase in present value per dollar of cost (C) thus:

$$= k - kT\Big($$

$$(4) \qquad \frac{\Delta PV}{C} = y = k(1-T\int_0^n d(t, n)e^{-rt}\,dt)$$

Unless the precise form of the depreciation policy d(t, n) is specified it is impossible to evaluate the quantitative impact of the investment credit. A number of qualitative conclusions, however, may be formulated even in the absence of an explicit depreciation policy. Clearly ΔPV is always positive: the introduction of an investment credit always increases an investment's present value no matter what depreciation policy is followed and no matter what the characteristics of the investment opportunity may be.[9] This conclusion follows from the fact that the maximum value of the integral in equation (4) is unity[10] and the tax-rate is also less than unity. The entire expression on the right hand side is, therefore, always positive. Obviously the increase in present value per dollar of cost is directly proportional to the size of the investment credit. It is also clear that for a given asset the lower the tax-rate the higher the increase in present value per dollar of cost. This increase, however, can never exceed k. This limiting case would occur if the corporate tax-rate

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9 All marginal investments will have a positive present value as a result of taking the credit and some sub-marginal projects will be pushed over the borderline.

10 When r = 0.

becomes zero or if corporations used exceedingly high costs of capital coupled with depreciation policies which favored delayed write-offs. On the other hand the increase in present value will never drop below zero. This limiting case would occur for a tax-rate of unity coupled with either a depreciation policy which permitted immediate write off of an asset or a cost-of-capital of zero. The investment credit has a more stimulating effect if the corporation bases its decisions on straight line depreciation rather than on an accelerated form of depreciation policy. If two corporations consider identical investment opportunities and use identical depreciation policies the effect of the investment credit will look more favorable to the corporation which uses the higher cost-of-capital. This follows from the fact that dy/dr is positive, thus:

$$(5) \qquad \frac{dy}{dr} = Tk\int_0^n t\,d(t, n)e^{-rt}\,dt > 0$$

An analysis of the effect of the investment credit on assets which differ only in their economic lives is more complicated and requires an explicit specification of d(t, n). This effect may be examined by considering the sign of $\frac{dy}{dn}$ which is given by:

$$(6) \qquad \frac{dy}{dn} = -kT\left[\int_0^N \frac{\partial}{\partial n}(d(t, n))e^{-rt}\,dt + d(n, n)e^{-rn}\right]$$

and hence the sign of dy/dn depends on the sign of the term in square brackets which in turn is negative.[11] Hence dy/dn is positive and the investment credit has a more beneficial effect on longer lived assets.

From equation (4) it is clear that given the institutionally defined parameters k and T plus the economic life of the investment the quantitative effect of the credit requires specification of d(t, n). Assume that d(t, n) represents straight-line depreciation that is, d(t, n) equals n^{-1} for each value of t. Substituting this explicit function for d(t, n) into the general expression for the increase in present value gives:

$$(7) \qquad \frac{\Delta PV}{C} = k\left[1 - \frac{T}{nr}\left(1 - e^{-rn}\right)\right] = f(T, k; nr)$$

From equation (7) it is evident that where either r or n is very large, or where their product is large, the increase in present value per dollar of cost is approximated simply by k, that is 7%. A precise quantitative evaluation of the impact of the investment credit requires simply the tabulation of the function f(T, k; nr) which, given the institutional parameters T and k, is a function of the single variable nr. This function is tabulated in Table 1. For convenience the life and the cost-of-capital are tabulated separately. Thus a corporation which buys a $1,000 asset which has a 10-year life and employs straight line depreciation will benefit to the extent of $46.99 if it discounts at 10% ($ 54.26

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[11] This can be seen by noting that $\delta(d(t, n)/\delta n < 0$ and $\int_0^n d(t, n)dt = 1$

for r = 20%) as a result of taking the investment credit. Table 2 provides the same information but on the assumption of a lower tax-rate.[12]

Tables similar to Tables 1 and 2 could be easily generated for other "institutionalized" depreciation policies. It is interesting to consider, however, what the stimulant to investment would be if a "theoretical" depreciation policy were followed. For example, say the depreciation policy is such that an annuity is set aside each period as the depreciation allowance subject to the condition that the present value of these allowances equals the cost of the asset.[13] If this annuity is X per dollar of depreciation base then X is the solution to the equation:

$$(8) \qquad X \int_0^n e^{-rt}\, dt = 1$$

and hence d(t, n) in this case is $r(1-e^{-rn})^{-1}$. If a corporation employed this policy or an equivalent one[14] then equation (4) would give:

12
Careful interpretation is required here. The increases tabulated do not reflect the double effects of (i) the investment credit and (ii) a change in the tax-rate. The effect considered is that of the investment credit applied under conditions of a different tax-rate. The problem of evaluating the double effects would involve the use of T in equation (1) above and T' (the simultaneous change in the tax-rate) in equation (2). Here the simpler problem is considered, namely, the comparison between the effects of the investment credit applied to investment under different tax-rates.

13
See Lutz and Lutz, The Theory of Investment of the Firm, chap. XIX. It is assumed that the discounting of the depreciation allowances is at the same rate as that applied to the cash flows.

14
Obviously the annuity assumption is no more than a simplifying one. Any depreciation policy which satisfies the equation $\int_0^n d(t, n)e^{-rt}\, dt = 1$ will lead to the same discussion above. A limiting case, but one interesting from a fiscal policy point-of-view, is that one which allows immediate depreciation of the cost of the asset. Here d(t, n) = 1 for the first period and is zero for all other values of t. It should, however, be noted that this case does not necessarily imply $\int_0^n d(t, n)dt = 1$.

TABLE 1*

INCREASE IN PRESENT VALUE
PER DOLLAR OF COST

R \ N	4	6	8	10	15	20
.05	.0123363	.0257017	.0399991	.0413554	.0443922	.0469907
.10	.0133330	.0284186	.0449445	.0469908	.0511480	.0542631
.15	.0142093	.0306660	.0488029	.0511480	.0555274	.0584708
.20	.0149815	.0325353	.0518431	.0542631	.0584708	.0610667
.25	.0156636	.0340986	.0542631	.0566352	.0605216	.0627691
.30	.0162676	.0354137	.0562092	.0584708	.0620010	.0639484
.35	.0168038	.0365262	.0577905	.0599141	.0631031	.0648047
.40	.0172810	.0374728	.0590887	.0610667	.0639484	.0654515

* TAX-RATE = .52

TABLE 2*

INCREASE IN PRESENT VALUE
PER DØLLAR ØF CØST

R \ N	4	6	8	10	15	20
.05	.0133937	.0277176	.0428838	.0441097	.0468545	.0492032
.10	.0142946	.0301732	.0473537	.0492032	.0529607	.0557763
.15	.0150866	.0322046	.0508411	.0529607	.0569190	.0595793
.20	.0157846	.0338941	.0535890	.0557763	.0595793	.0619256
.25	.0164011	.0353071	.0557763	.0579202	.0614330	.0634643
.30	.0169470	.0364957	.0575353	.0595793	.0627701	.0645303
.35	.0174317	.0375012	.0589645	.0608839	.0637662	.0653043
.40	.0178630	.0383568	.0601378	.0619256	.0645303	.0658889

* TAX-RATE = .47

$$(9) \qquad \frac{\Delta PV}{C} = k(1-T)$$

which is independent [15] of n, the life of the asset. This result will be derived from a different approach later where the effect of the investment credit on an asset's life is discussed. There is, of course, very little difference between these two different depreciation policies--straight line and "theoretical"--if the product rn is small. This can be seen if e^{-rn} is expanded as a Taylor's series as far as a linear function in rn. Then equation (7) becomes:

$$(10) \qquad k\left[1 - \frac{T}{nr}(1 - (1 - nr + \ldots))\right] = k(1-T)$$

which corresponds exactly [16] with equation (9).

So far the possible effects of salvage value have been ignored by assuming that the asset has zero salvage value. Relaxing this simplifying assumption let S be the salvage value of the asset. This modification

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[15] k, of course, takes on different values for various ranges of n (see Appendix A).

[16] For an approximation of e^{-rn} by $\sum_{x=0}^{n} (-rn)^x/X!$ up to a linear function the value of $f(T, k; rn)$, for an asset having n = 10 and r = .05, is .0384. The quadratic approximation gives .0427. The correct value for $f(T, k; nr)$ is .0413554 (assuming T = .52).

leads to essentially no basic changes in the analysis presented above. The modifications required would be the addition of the term Se^{-rn} to the right-hand sides of equations (1) and (2) along with the appropriate readjustments to the depreciable base and the investment credit. The change in the present value of an asset having salvage value can then be examined in the same way as equation (4) was examined except that the increase in present value is in terms of the net cost, that is C reduced by the salvage value. This line of analysis again leads to the need to make explicit assumptions with respect to the depreciation policy before any quantitative effects can be computed. Tables 1 and 2 can again be used and applied to the net investment to find the overall effect of the credit.

The effect of fiscal measures on the age-distribution of assets is an important question. Generally they are advanced and defended on the ground that they do not distort managerial decisions on questions such as the optimal lives of assets. Does the investment credit satisfy this requirement of neutrality?

An approach to answering this question may be made through the present value model outlined above. Employing the same notation but regarding the parameter n as a variable the problem is to find that value of n which maximizes the net present value of the asset.[17] This procedure

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[17] See Lutz and Lutz, The Theory of Investment of the Firm, chapter VIII.

is applied to the cash flows before the use of the credit as well as to the cash flows after applying the credit and the results compared.

The present value of an asset having salvage value (without the credit) is given by:

$$(11) \qquad PV_0 = \int_0^n (1-T)R(t)e^{-rt}\,dt + T(C-S)\int_0^n d(t, n)e^{-rt}\,dt - C + Se^{-rn}$$

To find the optimal life the derivative of equation (11) with respect to n is equated to zero. This leads to:[18]

$$(12) \qquad (1-T)R(n)e^{-rn} + T(C-S)\left[\int_0^n \frac{\partial}{\partial n}(d(t, n)e^{-rt})\,dt + d(n, n)e^{-rn}\right] = rSe^{-rn}$$

The corresponding expression for the optimizing condition if the investment credit is used in the calculations is:

$$(13) \qquad (1-T)R(n)e^{-rn} + T(C-S)\left[\int_0^n \frac{\partial}{\partial n}(d(t, n)e^{-rt})\,dt + d(n, n)e^{-rn}\right] = rSe^{-rn} + TCk\left[\int_0^n \frac{\partial}{\partial n}(d(t, n)e^{-rt})\,dt + d(n, n)e^{-rn}\right]$$

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[18] This is simply a more complicated form of the familar optimal life condition. See Lutz and Lutz, Ibid., chapter VIII. The Lutzes do not include taxes explicitly in their model. Thus setting T = 0 in equation (12) leads to the optimizing condition R(n) = rS which is a special case of their equation (2) p. 164 since salvage value is assumed to be a constant in this model.

Thus the value of n which satisfies equation (12) is the optimal life of the asset in the absence of the investment credit; and the value of n satisfying equation (13) is the optimal life of the same asset assuming the investment credit is applied. Since the term in square brackets on the right-hand side of equation (13) is negative[19] the net effect of the credit is to shorten optimal lives.[20]

In the discussion of the impact of different depreciation policies in terms of changes in present value it was noted that some depreciation policies led to an effect independent[21] of the life. This suggests that perhaps the use of the investment credit would be neutral with respect to the optimal life problem if one such depreciation policy were followed. Examining the optimizing conditions for the two cases--pre-investment credit and post-investment credit--given by equations (12) and (13) it is clear that no change in optimal life would be necessary if the term in square brackets on the right-hand side of equation (13) were zero, for in that event the two optimizing conditions match term by term.

The theoretical depreciation formula discussed above is:

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[19] See footnote 11.

[20] Theoretically there is no reason to suppose that the optimal life is a unique quantity. Uniqueness could only be achieved by a more rigorous specification of the functions R and d. Given these functions and C, S and r together with the institutional parameters T and k the method of finding the optimal life is to try various values of n (and the associated value of k) until equation (13) is satisfied. Since k is a step function in n this can lead to complications. It is very difficult to generalize about the magnitude of the differences between the optima but certainly for assets having lives well above the last break in the step function (8 years) there is clearly a systematic downward bias as a result of the investment credit. In the four- to eight-year range this is not clear since changes in k will tend to compensate.

[21] See the argument leading to equation (9).

$$(14) \qquad d(t, n) = r(1-e^{-rn})^{-1} \quad 0 \leq t \leq n$$

Hence,

$$(15) \qquad \int_0^n \frac{\partial}{\partial n}(d(t, n)e^{-rt})dt + d(n, n)e^{-rn}$$

is equivalent to:

$$(16) \qquad \frac{-r^2 e^{-rn}}{(1-e^{-rn})^2} \int_0^n e^{-rt}\,dt + \frac{re^{-rn}}{(1-e^{-rn})}$$

which reduces easily to zero. Thus if corporations employed depreciation policies having the property that the present value of the depreciation allowances equalled the initial cost[22] the introduction of the investment credit would not alter the optimal life.

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22 Or, the limiting case of this (see footnote 14), that is, expensing assets in total immediately--the most extreme form of acceleration.

In summary: starting out with an investment opportunity defined in a general way but having zero salvage value the effect--in terms of increased present value--of introducing the investment credit is generally found to depend on the method of depreciation used, the life of the asset and the interest rate used in discounting. The longer lived assets and those being discounted at higher costs-of-capital experience the largest increase in present value. The less accelerated the form of depreciation policy used the more the asset benefits from employing the investment credit. But in this connection it was noted that some forms of "theoretical" depreciation lead to results independent of life and interest rates. These results carry over into investments which have non-zero salvage value. Finally the tendency for bias to be introduced into the effect on optimal lives--resulting in a shortening of lives--produced by using the investment credit was discussed but the absence of bias found if theoretical depreciation methods were employed.

APPENDIX A

INVESTMENT CREDIT PROVISIONS

This appendix provides a brief indication of the law relating to the investment credit. For the details, the reader should consult section two of the Revenue Act of 1962.

The credit varies depending on the life of the asset in question. The full 7% is available for assets having lives of 8 or more years. Thus the purchase of a $1,000 piece of equipment which has a 10 year life yields a tax credit of $70. This $70 is the deduction made from the corporation's tax liability. The amount of the capital expenditure which may be depreciated is also reduced by $70. For assets with lives less than this the following schedule applies:

for lives of 6 or 7 years a credit of 2/3 of 7%

and for lives of 4 or 5 years a credit of 1/3 of 7%.

Assets with lives less than 4 years do not qualify. The investment expenditures must, of course, be for appropriate kinds of assets before they qualify for the credit under the law. But most kinds of tangible assets bought by business qualify, even the purchase of used assets. In this latter case, however, only purchases up to $50,000 in any one year would qualify. The investment-credit rate schedule for different lives noted above apply in this case too. Where the tangible asset is acquired and, at the same time, the purchaser trades-in an old asset, the basis of the investment credit is reduced by the value of the trade-in, that is, the investment credit is computed on the net investment.

Important limitations exist in the availability of the investment credit. Clearly the amount of the credit in a given year cannot exceed the tax-liability for that year. Carry-back and carry-forward provisions to the extent of three and five years respectively are available to the corporation so that it may exercise the use of the credit. Perhaps a more important limitation is the "twenty-five-percent limitation." If the level of qualified expenditures in any given year gives rise to an investment credit in excess of $25,000 the maximum credit which can be claimed is $25,000 plus 25% of the excess (assuming the first limitation is not already operative). The balance of the credit due to the corporation but not available on account of these limitations can be recouped through the carry-forward and carry-back provisions noted above.

One other remaining feature of the law which apparently has given rise to stimulating investment[1] is the provisions pertaining to leased equipment and the effects on lessees and lessors. The lessor has the option of passing the tax-credit on to the lessee. For leases of 8 or more years the lessee[2] would obtain the 7% tax-credit in the usual way.

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1 See Business Week, January 19, 1963, pp. 60 and 65.

2 If he is the first lessee of new equipment.

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